



**Subject: Chains, Rings & Spectroscopy**  
**Code: 2814**

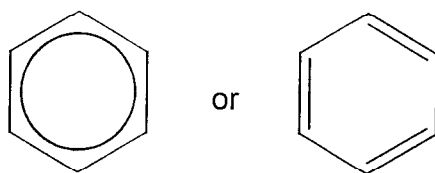
**Session: January**  
**Year: 2002**

**Final Mark Scheme**

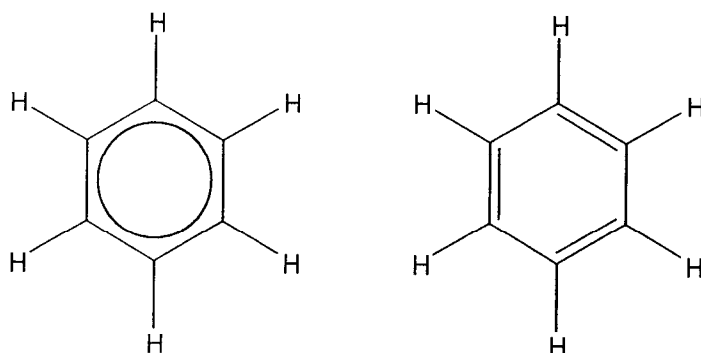
<b>MAXIMUM MARK</b>	<b>90</b>
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1 (a) structure.

[2]



accept:

empirical formula: CH ✓ **NOT** C<sub>6</sub>H<sub>6</sub> or (CH)<sub>6</sub>(b) HNO<sub>3</sub> ✓  
H<sub>2</sub>SO<sub>4</sub> ✓

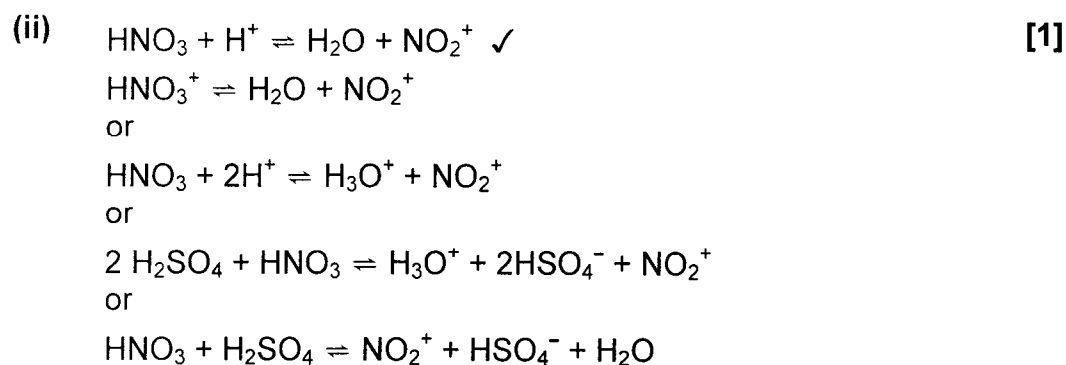
[2]

accept words or formulae

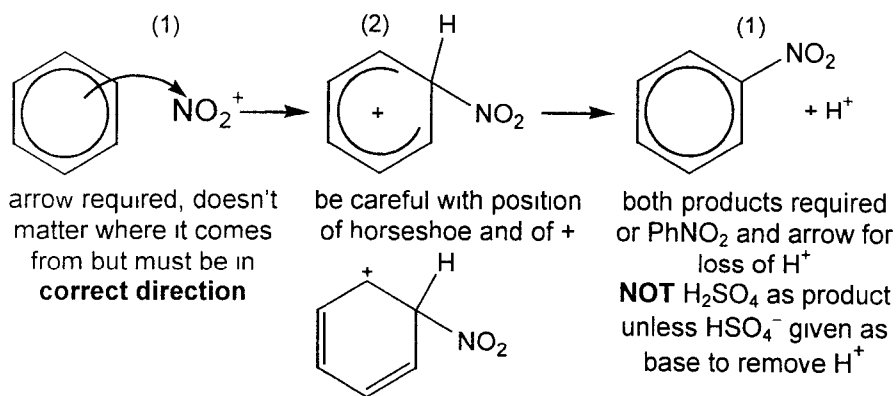
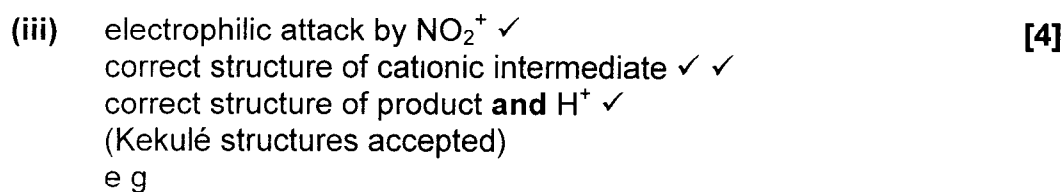
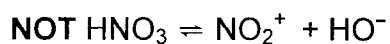
**NOT** dilute acids – penalise dilute ONCE only; so dil H<sub>2</sub>SO<sub>4</sub> + dil HNO<sub>3</sub> gets (1)**NOT** correct words with wrong formula eg nitric acid HNO<sub>2</sub>**NOT** wrong words with correct formula eg nitrous acid, HNO<sub>3</sub>

ignore state symbols

mark any wrong answers and subtract from correct answers to min of 0



equation must balance;  $\rightleftharpoons$  not essential



- (d)  $M_r \text{ C}_6\text{H}_6 = 78 \checkmark$  [4]  
 $M_r \text{ C}_6\text{H}_5\text{NO}_2 = 123 \checkmark$

all correct working  $\checkmark$   
allow e.c.f from wrong  $M_r$   
e.g.

$$\text{moles C}_6\text{H}_6 = \frac{10}{78} = 0.128$$

$$100\% \text{ yield} = 0.128 \times 123 = 15.77\text{g}$$

$$\% \text{yield} = \frac{13.3}{15.77} \times 100 = \mathbf{84.3\%} \checkmark \text{ (answer) must have 3 sig figs}$$

accept any answer in the range  $84.2 \rightarrow 84.5$  as 'correct'  
Correct answer on its own = 4 marks

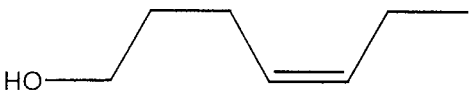
**Total = 14**

- 2 (a) Only one C substituent on N ✓ [1]  
 or two H substituents on N  
 or  $\text{RNH}_2$  as a general structure  
**NOT** attached to a C only attached to one other carbon ie  $\text{RCH}_2\text{NH}_2$   
**NOT**  $\text{NH}_2$  is on the first/end carbon
- (b)  $\text{C}_2\text{H}_5\text{NH}_2 + \text{H}^+ \rightleftharpoons \text{C}_2\text{H}_5\text{N}^+\text{H}_3$  balanced eq ✓ [2]  
 structure ✓ ( + is essential)  
 any acid OR water accept in equation  
 or  
 $\text{C}_2\text{H}_5\text{NH}_2 + \text{HCl} \rightleftharpoons \text{C}_2\text{H}_5\text{N}^+\text{H}_3 \text{ Cl}^-$   
 ( $\rightleftharpoons$  not essential)
- (c) (i) Stage I: [5]  
 $\text{H}_2$  + catalyst, or  $\text{H}_2$  + specified metal catalyst e.g. Ni, Pd, Pt; or  
 metal ✓ **NOT** acid catalyst  
  
 or  $\text{Sn/HCl}$  } words or formula  
 or  $\text{Fe/HCl}$  }  
 or Na in ethanol or liq.  $\text{NH}_3$   
  
Stage II:  
 $\text{NaNO}_2$  ✓, an acid e.g.  $\text{HCl}$  ✓  
 or  $\text{HNO}_2$  ✓✓  
 $\text{HNO}_3$  /  $\text{HCl}$  gets (1)  
**NOT** just  $\text{HCl}$  only; not eg  $\text{HCl} + \text{H}_2\text{SO}_4$   
  
Stage III:  
 Phenol ✓, (aq )  $\text{NaOH}$  or base or alkali ✓
- (ii) Stage I: [2]  
 $\text{C}_7\text{H}_7\text{NO}_2 + 3\text{H}_2 \rightarrow \text{C}_7\text{H}_9\text{N} + 2\text{H}_2\text{O}$  ✓  
 or  $6[\text{H}]/6\text{H}$   
  
Stage III:  
 $\text{C}_7\text{H}_7\text{N}_2^+\text{Cl}^- + \text{C}_6\text{H}_5\text{ONa} \rightarrow \text{C}_{13}\text{H}_{12}\text{N}_2\text{O} + \text{NaCl}$  ✓  
 or without the  $\text{Cl}^-$  or without the  $\text{Na}^+$  or without both  
 or  $\text{C}_7\text{H}_7\text{N}_2^+\text{Cl}^- + \text{C}_6\text{H}_5\text{ONa} + \text{NaOH} \rightarrow \text{C}_{13}\text{H}_{12}\text{N}_2\text{O} + \text{NaCl} + \text{H}_2\text{O}$   
  
 Both equations **MUST** be balanced  
 ecf: if no base in Stage III then allow phenol giving  $\text{HCl}$  and  
 product in equation
- (iii) Dyes ✓ [1]  
 allow indicators, pharmaceuticals

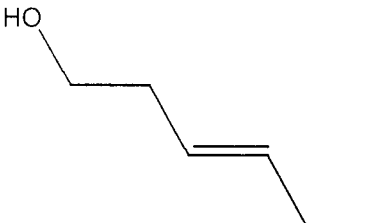
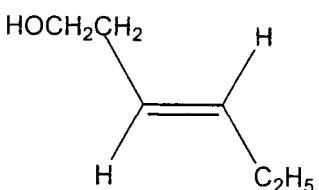
Total = 11

3 (a) (i) Methyl butanoate ✓ [1]

(ii) Warm / hot / boil / reflux ✓  
 water or aqueous or dilute ✓  
 NaOH / KOH / HCl / H<sub>2</sub>SO<sub>4</sub> ✓  
 acid/alkali/base H<sup>+</sup> / OH<sup>-</sup>  
 or any strong acid, **NOT** HNO<sub>3</sub> } words or formulae [3]

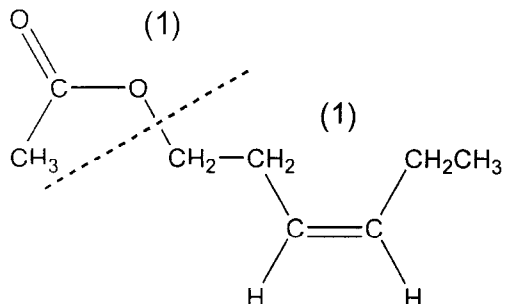
(b) (i)  [1]

ONLY ✓

(ii)  or  [1]

✓

not necessarily skeletal, but MUST show the C=C stereochemistry  
 (right angles not penalised)

(iii)  [2]

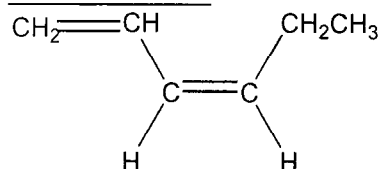
correct left of O-C bond ✓  
 correct right of O-C bond ✓

must show bonding in ester and alkene;  
 structure with CH<sub>3</sub>COO... gets (1) only if rest is correct;  
 structure with trans double bond gets (1) if rest is correct

(c) (i)  $M_r$  B:  $C_6H_{12}O$   $72 + 12 + 16 = 100$  ✓ [1]

(ii) Mass spectroscopy / spectrometer / spec / spectrum ✓ [1]

(iii) Structure of C: [2]



✓  
or any other correct drawing of hexa-1,3-diene  $C_6H_{10}$   
or any hydrocarbon of  $M_r$  82 correctly drawn

Type of reaction:

dehydration ✓

or loss of water or elimination

**NOT** condensation

**Total = 12**

- 4 (a) **Two** of ethene, chloroethene, phenylethene or any alkene monomer [3]  
✓✓

One reason eg all polymer monomers ✓ not benzene  
**NOT** for cracking or fuels

- (b) Diagram with correct structure of poly(propene), [7]  
not necessarily 3-D (1)

Polymer has chiral centres (1) **ESSENTIAL MARK**

can have. all methyls same chirality / 'side' of chain (1)  
methyls alternating chirality / 'side' (1)  
all methyls random chirality / 'side' (1)

same = isotactic, alt = syndiotactic, random = atactic

all 3 names correctly assigned (1)

- (6) available for chemistry, of which  
at least (1) must be for a diagram ✓

QWC. At least two coherent sentences with reasonable spelling and  
punctuation. Show as QWC x or ✓ (1)

MAX = 7

- (c) (i) For each signal. (1) for identification and (1) for reason. [6]

δ 11.7. H of -OH or -COOH; one H: ✓  
because it exchanges with D<sub>2</sub>O/labile proton }  
or singlet because it has no ✓  
H atoms on an adjacent atom  
or data table 11.0 – 11.7 }

δ 2.4. 2H of -CH<sub>2</sub>- ✓  
quartet because it has 3 H atoms on the adjacent carbon }  
(n+1) = 4 lines ✓  
or data table 2.0 – 2.9 CHC=0 }

δ 1.1. 3H of CH<sub>3</sub>- ✓  
triplet because it has 2 H atoms on the adjacent carbon }  
(n+1) = 3 lines ✓  
or data table 0.7 – 1.6 CH<sub>3</sub>-R }

- (ii) It is due to OH and the proton can **exchange/swap/substitute** [1]

(1) with the D in D<sub>2</sub>O ✓

or D replaces H

**NOT** just reacts with water

**Total = 17**



- 5 (a)  $\left. \begin{array}{l} \text{HOOC}(\text{CH}_2)_4\text{COOH} \checkmark \\ \text{H}_2\text{N}(\text{CH}_2)_6\text{NH}_2 \checkmark \end{array} \right\} \text{ words or formula} \quad [2]$   
(or any pair of monomers that would work)

- (b) condensation polymerisation  $\checkmark$  [2]  
small molecule /  $\text{H}_2\text{O}$  is eliminated  $\checkmark$

- (c) **max of 6 marks from:** [7]  
  - structural similarity  
e.g. peptide/amide link (1)

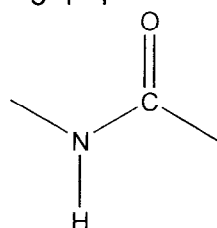


diagram (1)

both form H-bonds between molecules (1) picture of H-bond (1)  
or can be in second bullet point

- chemical similarity  
e.g. both condensation polymers (1)  
 $\sim\text{NH}_2 + \text{HOOC}\sim \rightarrow \sim\text{NHCO}\sim + \text{H}_2\text{O}$  equation (1)  
both are hydrolysed (1) back to monomers (1)

- differences  
e.g.  
protein can be water-soluble, nylon not (1)  
protein biodegradable, nylon not (1)  
nylon regular, protein irregular (1)  
nylon one or two monomers, protein many (1)  
proteins are made from amino acids (1) which can be chiral (1)  
proteins are natural and nylon is synthetic (owtte) (1)

**At least one mark from each bullet point and not more than three from each bullet point.** MAX = 6

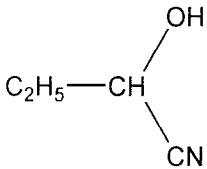
**Plus**

Quality of written communication  $\checkmark$

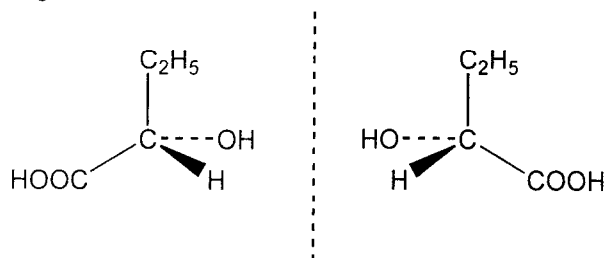
Correct reference to **two** chemical terms e.g. condensation, peptide, biodegradeable.

Show as QWC x or  $\checkmark$

**Total = 11**

- 6 (a) (i) propanone ✓ [1]  
accept acetone or propan-2-one
- (ii) propanal ✓ [1]  
accept propanaldehyde but **not** ethanal
- (b) (i) *reagent(s)*: e.g. 2,4-dinitrophenylhydrazine ✓ [2]  
in words or formula  
*observation*: e.g. orange / red / yellow precipitate / crystals ✓
- (ii) no mark for observation if no reagent given  
*reagent(s)*: e.g. ammoniacal AgNO<sub>3</sub> ✓ or Ag<sub>2</sub>O or Ag<sup>+</sup> or Tollens [3]  
*observation for D*: No change ✓  
*observation for E*: silver (mirror) ✓ grey ppte
- or similarly for another **chemical** test that works e.g. acid dichromate, Fehlings or CHI<sub>3</sub> test
- (c) (i) Marked cross at  $\nu \sim 1700$  ✓ [2]  
D has carbonyl group or ketone or C=O ✓
- (ii) e.g. Reduction CH<sub>3</sub>COCH<sub>3</sub> → CH<sub>3</sub>CHOHCH<sub>3</sub> (1) [2]  
(or product is an alcohol)  
new (broad) peak at  $\sim 3230 - 3550 \text{ cm}^{-1}$  (1)  
loss of peak at  $\sim 1700 \text{ cm}^{-1}$  (1)  
any two good points ✓ ✓
- (d) (i)  [1]  
✓ allow C<sub>2</sub>H<sub>5</sub>CH(OH)CN

(ii) e.g.



✓✓

with at least one bond shown out of plane of paper

(1) for correct structure of K, but poor 3-D diagrams

(1) for correct 3-D structures of J

watch out for  $\text{-CN}$  instead of  $\text{-COOH}$ allow ecf from (i) e.g.  $\text{-CH}_3$  instead of  $\text{-C}_2\text{H}_5$ 

allow correct 3-D diagrams of amide as hydrolysis product instead of acid

**Total = 14**

- 7 (a)  $\text{RCH(NH}_2\text{)COOH}$  or  $\text{RCH(NH}_3^+\text{)COO}^-$  ✓ [1]
- (b) (i)  $\text{H}_3\text{N}^+\text{CH}_2\text{COO}^-$  ✓ [1]  
accept  $\text{NH}_3^+\text{CH}_2\text{COO}^-$
- (ii)  $\text{COOH}$  is acidic / loses  $\text{H}^+$  ✓ [2]  
 $\text{NH}_2$  is basic / has a lone pair / gains  $\text{H}^+$  ✓ (not H transfer)
- (iii) High m.p. means strong **intermolecular** / between molecules [3]  
(1) forces in the solid glycine; ✓  
coulombic (ion/ion) forces (1) in zwitterion are strong; ✓  
any comment on why hydroxyethanoic acid is lower ✓  
e.g. H-bonding (1) holds crystal together
- (c)  $\text{H}_3\text{N}^+\text{CH}_2\text{COOH}$  ✓  $\longleftrightarrow$  glycine  $\rightarrow$   $\text{H}_2\text{NCH}_2\text{COO}^-$  ✓ or  $\text{H}_2\text{NCH}_2\text{COONa}$  [4]  
↓  
 $\text{H}_2\text{NCH}_2\text{COOCH}_3$  ✓  
or  $\text{H}_3\text{N}^+\text{CH}_2\text{COOCH}_3$   
any correct balancing ion ✓

**Total = 11**